

Ping Du, Ph.D.

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EDUCATION

PhD, Mechanical Engineering, Sep. 2012

Boston University, College of Engineering, Boston, MA, USA.

Thesis Advisor: Dr. Xin Zhang

Thesis Title: "Viscoelastic Characterization and Modeling of PDMS Micropillars for Cellular Force Measurement Applications"

GPA: 3.99/4

MS, Materials Science and Engineering, Jul. 2006

Tsinghua University, School of Mechanical Engineering, Beijing, China.

BS, Mechanical Engineering and Automation, Jul. 2003

Tsinghua University, School of Mechanical Engineering, Beijing, China.

RESEARCH AND WORK EXPERIENCE

Medtronic, Inc. Mounds View, MN, USA.

R&D Engineer Contractor, Oct. 2012 - Present

- Provide numerical modeling support for a variety of medical devices and manufacturing process development
- Developed a general procedure to characterize the elastic/hyperelastic and viscoelastic properties of common polymers used in medical devices. Evaluated their effects on the critical component (seals relaxation, wire fatigue) performance during the device life time. The outcomes included effectively improved simulation accuracy and ultimately minimize the gap with experiments.
- Modeled the superelastic behavior of shape memory alloy (Nitinol) components using ABAQUS user materials, and processed batch data using Python scripts. The reliability of the device under user conditions was successfully evaluated.
- Studied the various punch designs for the progressive shield forming process to improve the cosmetic appearance and patient comfort. The model was further used to optimize the process without costly and time-consuming tooling cycles.
- Simulated the molten solder flow and heat transfer using ANSYS CFX to optimize the copper trace design for laser soldering of circuit board. An insight physical understanding of the process was established (including the surface tension, contact angle, gravity force).

Boston University, Boston, MA, USA.

Research Assistant, Laboratory for Microsystems Technology (LMST), 2007 - 2012

- Lead researcher in NSF-funded projects related to mechanical characterization and modeling of both soft polymers and thin film ceramics.
- **Viscoelastic characterization and modeling of PDMS micropillar force transducers.**
- Developed theoretical models and experimental methodologies to comprehensively characterize the viscoelastic properties of PDMS in both time domain (relaxation modulus)

- and frequency domain (complex modulus) using advanced nanoindentation techniques.
- Developed an enhanced viscoelastic Timoshenko beam formula to investigate the effects of loading rate and pillar aspect ratio on the cellular contraction force calculation.
 - Constructed 3D micropillar model (in ABAQUS) and simulated the cardiac myocyte contraction force in the frequency domain by incorporating the Fourier series expression of cellular contraction and complex modulus of PDMS material.
 - Systematically studied the electrical properties (dielectric constant) and mechanical properties (viscoelasticity, elastic modulus) of PDMS-conducting polymer nanowire composites.
 - **Mechanical properties of sputtered silicon oxycarbide thin films.**
 - Fabricated Silicon oxycarbide (SiOC) films by RF magnetron co-sputtering technique.
 - Characterized the film composition using EDS, SEM, FTIR and ellipsometer.
 - Measured the residual stress by film-substrate curvature technique, and the Young's modulus and hardness by nanoindentation.
 - Discussed the effect of carbon content and thermal annealing temperature on the mechanical properties of SiOC from a microstructure aspect.
 - **Fabrication and modeling of conducting polymer trilayer actuators.**
 - Synthesized conducting polymer (polypyrrole) by electrochemical deposition.
 - Developed a general multilayer beam bending model to account for the actuator consisting of arbitrary number of layers.
 - Characterized the electromechanical correlation of the actuators.

Teaching Assistant, Department of Mechanical Engineering.

- Mechanics of Materials (ME305), Spring 2009.
- Engineering Mechanics (EK301), Fall 2008.
- Engineering Computation with Matlab (EK127), Fall 2006 - Spring 2008.

Entegris, Inc. Burlington, MA, USA.

Material Analysis Intern, Jul. 2011 – Sep.2011

- Created a database for the release ability of various industrial plastics to the DLC coated injection molds.
- Independently learned the operation of a universal mechanical tester for wear and scratch testing.
- Prepared an operation manual and application notes of the tester for documentation and training purpose.

Tsinghua University, Beijing, China.

Research Assistant, Key Laboratory for Advanced Manufacturing, 2003 - 2006

- Thixotropic die casting and process control of semi-solid aluminum alloys. Optimized the reheating process in three heating steps and one holding step using electromagnetic induction heater. The thixotropic ingots achieved the optimal microstructures with even spherical solid phase and liquid phase.

CITIC Dicastal Wheel Manufacturing Co. Ltd., Qinhuangdao, China.

Mechanical Engineer Intern, Sep. 2002 - May 2003

- Designed a mold temperature control system for the low pressure die casting of aluminum alloy wheels using Programmable Logic Controller (PLC). Obtained real-time monitoring of the mold temperature, and regulation of cooling system.

TECHNICAL SKILLS

- **Mechanics of Materials** Young's modulus, Hardness, Residual stress, Thermomechanical analysis. Viscoelasticity in time / frequency domains (stress relaxation, creep, complex modulus). Fatigue, Fracture, Wear rate, Scratch resistance.
- **Material Characterization** Mechanical: Nanoindenter, Universal mechanical tester, Rockwell hardness. Electrical: Impedance analyzer, LCR meter, Four point probe. Micro-structure: SEM/EDS, AFM, FTIR, UV-Visible, Zygo, XRD, Ellipsometer.
- **Computational Skills** FEA: **ABAQUS**, ANSYS, COMSOL. CAD: **Solidworks (certified)**, AutoCAD. Math: **MATLAB**, Mathematica, Maple. OS: Windows, Linux.

CERTIFICATIONS

1. Professional Development: Materials for Medical Devices

ASM International (Minnesota Chapter)

February 2013

2. Abaqus Training: Fracture & Failure, Coupled Eulerian-Lagrangian (CEL)

Dassault Systèmes Simulia Central

November 2012

3. Certified SolidWorks Associate (CSWA)

Dassault Systèmes Solidworks Corporation

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June 2012

PUBLICATIONS

Journal Articles

1. J. Dong, **P. Du**, X. Zhang. "Measurements of the Young's modulus and residual stresses of sputtered silicon oxynitride film using micro-structures". *Thin Solid Films*. (submitted)
2. **P. Du**, X. Lin, X. Zhang. "Tunable electrical and mechanical properties of PDMS and conducting polymer nanowire composites". *Journal of Physics D: Applied Physics*. (accepted)
3. **P. Du**, C. Cheng, H. Lu, X. Zhang. "Investigation of cellular contraction forces in the frequency domain using a PDMS micropillar based force transducer". *Journal of Microelectromechanical Systems*, **22**, 44-53, 2013.
4. **P. Du**, I-K Lin, X. Zhang. "Effects of composition and thermal annealing on the mechanical properties of silicon oxycarbide films". *Sensors and Actuators A: Physical*, **176**, 90-98, 2012.

5. **P. Du**, X. Zheng, I-K Lin, X. Zhang. "Effect of loading rates on cellular force measurements by polymer micropillar based transducers". *Applied Physics Letters*, **99**, 083701, 2011.
6. **P. Du**, I-K Lin, H. Lu, X. Zhang. "Extension of beam theory for polymer bio-transducers with low aspect ratios and viscoelastic characteristics". *Journal of Micromechanics and Microengineering*, **20**, 095016, 2010.
7. **P. Du**, X. Lin, X. Zhang. "A multilayer bending model for conducting polymer actuators". *Sensors and Actuators A: Physical*, **163**, 240-246, 2010.
8. **P. Du**, S. Li, J. Tang, D. Zeng. "Discussion of key questions on thixotropic die casting of semi-solid aluminum alloys". *Foundry Technology*, **27**(6): 545-549, 2006. (resulting from research prior to Ph.D.)
9. S. Li, **P. Du**, J. Tang, D. Zeng. "Reheating Process for the Semi-solid A356 Alloy". *Special Casting & Nonferrous Alloys*, **26**(12): 781-783, 2006. (resulting from research prior to Ph.D.)
10. Y. Xue, G. Li, J. Liu, X. Dai, Y. Yuan, S. Li, **P. Du**. "Comparison of Filling Process of A356 Alloy in Semi-solid Thixo-forming Die Casting with in Conventional Die Casting Based on Numerical Simulation with Flow-3D". *Special Casting & Nonferrous Alloys*, **26**(11): 710-712, 2006. (resulting from research prior to Ph.D.)

Conference Proceedings (Full Papers)

1. **P. Du**, C. Cheng, H. Lu, X. Zhang. "Complex modulus of PDMS and its application in cellular force measurement". *Proceeding of MicroTAS 2012*, Okinawa, Japan.
2. **P. Du**, X. Lin, X. Zhang. "Dielectric constants of PDMS nanocomposites by conducting polymer nanowires". *Proceeding of the 16th International Conference on Solid-State Sensors, Actuators and Microsystems (Transducers '11)*, Beijing, China, 2011, 645-648.
3. **P. Du**, X. Lin, X. Zhang. "Electromechanical coupling of polypyrrole trilayer actuators". *Proceeding of the 16th International Conference on Solid-State Sensors, Actuators and Microsystems (Transducers '11)*, Beijing, China, 2011, 478-481.
4. **P. Du**, X. Zheng, I-K Lin, X. Zhang. "Effect of loading rates on polymer micropillar-based force transducers". *Proceeding of the 16th International Conference on Solid-State Sensors, Actuators and Microsystems (Transducers '11)*, Beijing, China, 2011, 1432-1435.
5. **P. Du**, X. Lin, X. Zhang. "Characterization on the electrical properties of PDMS nanocomposites by conducting polymer nanowires". *Proceeding of 2010 Materials Research Society (MRS) Fall Meeting*, Boston, MA, 1312, 1-6.
6. **P. Du**, I-K Lin, H. Lu, X. Lin, X. Zhang. "Characterization on the viscoelastic property of PDMS in the frequency domain". *Proceeding of 2010 Materials Research Society (MRS) Fall Meeting*, Boston, MA, 1301, 1-6.

7. **P. Du**, I-K Lin, Y. Yan, X. Zhang. "Residual stress in sputtered silicon oxycarbide thin films". *Proceeding of 2010 Materials Research Society (MRS) Fall Meeting*, Boston, MA, 1299, 1-6.
8. I-K Lin, **P. Du**, Y. Zhang, X. Zhang. "Mechanical and Material Characterization of Bilayer Microcantilever-based IR detectors." *Proceeding of 2010 Materials Research Society (MRS) Fall Meeting*, 1299: 1-6.
9. **P. Du**, X. Zheng, I-K Lin, H. Lu, X. Zhang. "Extended Timoshenko beam formula for cellular contraction force calculation". *Proceeding of MicroTAS 2010*, Groningen, Netherlands.
10. **P. Du**, H. Lu, X. Zhang. "Measuring the Young's relaxation modulus of PDMS using stress relaxation nanoindentation". *Proceeding of 2009 Materials Research Society (MRS) Fall Meeting*, Boston, MA, 1222-DD02-03.
11. **P. Du**, X. Lin, X. Zhang. "Characterization of the correlation between current input and curvature output of polypyrrole trilayer actuators". *Proceeding of PowerMEMS 2009*, Washington DC, 578-581.
12. **P. Du**, X. Lin, X. Zhang. "Development of conductive polymer micro cantilever for conductivity measurement". *Proceeding of ASME 2008 International Mechanical Engineering Congress & Exposition*, Boston, MA, 67986.

Conference (Abstract / Poster Referred)

1. **P. Du**, C. Cheng, X. Zhao, H. Lu, X. Zhang. "Cellular Contraction Force Measurement in the Frequency Domain". *2012 Materials Research Society (MRS) Fall Meeting*, Boston, MA.
2. **P. Du**, X. Wang, I-K Lin, and X. Zhang. "Residual Stress, Modulus and Hardness of Silicon Oxycarbide Films". *2012 Materials Research Society (MRS) Fall Meeting*, Boston, MA.
3. **P. Du**, C. Chen, X. Lin, and X. Zhang. "High Dielectric Constants in Compliant PDMS and Conducting Polymer Nanowire Composites". *2012 Materials Research Society (MRS) Fall Meeting*, Boston, MA.
4. **P. Du**, C. Cheng, H. Lu, X. Zhang. "Viscoelastic characterization of PDMS in the frequency domain and its application in cellular force measurement". *NSF CMMI Engineering Research and Innovation Conference 2012 (Student Conference Fellowships)*, Boston, MA.
5. **P. Du**, C. Cheng, H. Lu, X. Zhang. "Frequency domain viscoelastic property of soft polymers as cellular force transducers". *2011 Materials Research Society (MRS) Fall Meeting*, Boston, MA.
6. **P. Du**, I-K Lin, H. Lu, X. Zhang. "Extension of beam theory for polymer bio-transducers". *16th US National Congress of Theoretical and Applied Mechanics*, 2010,

State College, PA.

7. **P. Du**, I-K Lin, H. Lu, X. Zhang. “Extension of beam theory for polymer bio-transducers” (Invited talk). *Society of Rheology 82nd Annual Meeting*, 2010, Santa Fe, NM.
8. **P. Du**, I-K Lin, H. Lu, X. Zhang. “Extension of beam theory for PDMS based bio-transducers with low aspect ratios and viscoelastic characteristics”. *Gordon Research Conference: Thin Film & Small Scale Mechanical Behavior*, 2010, Waterville, ME.
9. **P. Du**, X. Lin, X. Zhang. “Characterization of the relationship between current input and curvature output of polypyrrole bilayer actuators”. *5th International Workshop on Advanced Smart materials and Smart Structures Technology*, 2009, Boston, MA.
10. **P. Du**, X. Zhang, X. Lin. “Development of conductive polymer single layer cantilever for conductivity measurement”. *Hilton Head Workshop 2008*, Hilton Head Island, SC.

REFEREE EXPERIENCE

Materials Research Society
Sensors and Actuators A: Physical
Journal of Physics D: Applied Physics
Experimental Mechanics
Microelectronic Engineering

PROFESSIONAL AFFILIATIONS

American Society of Materials (ASM), 2011 – present.
Materials Research Society (MRS), 2008 – 2012.
American Society of Mechanical Engineers (ASME), 2008.
Institute of Electrical and Electronics Engineers (IEEE), 2011 – 2012.

LINKS

Blog <http://blogs.bu.edu/pdu/>
LinkedIn <http://www.linkedin.com/in/duping812>
Research Gate https://www.researchgate.net/profile/Ping_Du2/
Google Scholar http://scholar.google.com/citations?user=JQe_qSMAAAAJ&hl=en